THE DIFFICULT SCIENCES

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MISSION

A question I always ask myself when I'm invited to speak is: Why?

Two decades ago, I founded CONTACT, an interdisciplinary forum on the humanity's future. Each year our conference brings together scientists, science fiction writers and artists to exchange ideas, stimulate new perspectives and encourage serious, creative speculation about what may lie ahead for our species ... onworld and offworld. One of our primary goals is to promote the integration of human factors into space age research and policy.

So, I have a Mission: To make sure that humans stay at the center of the human future in space. Therefore, I have an investment in the inclusion in the space program of those disciplines that study humans.

To that end, I participated in the Workshop on the Societal Aspects of Astrobiology two years ago. (1) There were a lot of important folks there; Futurist Alvin Toffler, author Ben Bova, Jill Tarter and John Billingham of SETI, Dave Morrison and Baruch Blumberg of NASA. And there were also a bunch of anthropologists, sociologists, psychologists and the like who had come to demonstrate the contributions they believed that the Social Sciences could make to the Astrobiology program.

I'm one of those. O yes, I minored in Biology and Geology, but my BA is in Literature. And though I took my doctoral exams in both Biological and Cultural Anthropology, I'm nonetheless on of those -- a "soft" scientist!

SCIENCE VS SCIENTISTS

I teach both biological anthropology and anthropology of religion (often in the same semester) -- and I consider myself a scientist. As I learned it, science is a method, a systematic process for evaluating the data of the universe.

This means that science is not a worldview. For me, the construction of an increasing body of knowledge explaining empirical reality is not the goal of science, but of scientists. That's probably because we are human. We jest cain't help it. But as soon as we move beyond methodology to create a model or theory of how things are, we risk

becoming believers in science just as others are believers in religion -- and we often act that way. Our intellectual and emotional investment in our models motivates us to define "different" as "wrong." Though religion and science employ dissimilar methodologies, their human goal is often the same: To build an explanatory model of the universe that convinces ourselves and others that -- whatever the criteria for validation -- WE ARE RIGHT. As scientists, we should be on guard against our own biases.

TAKING A LOOK AROUND

Anthropologists can help here, since they are trained in a cross-cultural or global perspective, which sometimes appears lacking among space scientists and engineers. For example, NASA's research on human specifications has mostly limited its experimental subjects to Americans -- usually white, usually male -- rather than seeking to draw its engineering data from a representative sampling of the world's population as a whole.

And what about scientists themselves? If we could shrink the Earth's population to an island village of 100 people -- with all existing human ratios remaining the same -- this is how it would look (2):

- About 60 are Asians, 20 Europeans, and only 14 from the "New World"
- the majority would be female
- 70 of the 100 would be nonwhite
- 50 would suffer from malnutrition
- 70 would be unable to read
- Only 1 would have a college education
- NOBODY would own a computer

Now look around this room: Probably NONE of us would be on that island. Scientists are a splinter group, not a representative sample of our species; yet we often presume to speak -- and make decisions -- for all humanity.

THE ADAPTIVE VALUE OF RELIGION

Anthropologists also cannot help but notice that many scientists, while professing objectivity, tend to view other systems of belief as rivals, rather than as alternate intellectual strategies among humanity's adaptive resources. Religion, particularly, is seen as a competitor, but luckily (we scientists are sure) one which is outmoded, inferior and eventually doomed -- as if evolution's goal were to ultimately produce an entire species made up only of scientists. Yet there are few signs in the world at large that religion is on the decline; it has far more adherents and is gaining converts faster than science.

Social scientists have developed some methodological and analytical tools to test hypotheses and develop theories that can explain, if not precisely predict, many aspects of religious behavior, which may be both enlightening and convincing to space scientists and engineers. Due to our own secular society's limitations in the field of religious experience, we lack a personal, evolutionary and cross-cultural understanding of religion.

This deficiency leads us to underestimate religion's past, present, and perhaps future role as humanity's most powerful and active mechanism for change. Especially in dealing with phenomena involving strong and widespread emotional impact, religion may provide our species with some vital adaptive intellectual resources that science cannot. (3)

a) For one thing, religion can answer some important questions that science cannot, questions that humans, forced by their intellectual or emotional crises, will always ask. Chaos theory, Brownian motion, the uncertainty principle and coincidence of time and space are surely unsatisfying explanations for people whose hearts are broken by the loss of lover, relative or friend. Accidents are things that happen to others; as affected individuals, we seek more accessible causes. The 9/11 catastrophe was a clear example of this very human response. In some vital areas of human needs, science may continue to be a lesser tool, so long as it remains committed to the limits imposed by the rigors of its method and the laws of physics. Religion, with no such compunctions, can consequently encompass more things in heaven and earth than are dreamt of in science's philosophy.

b) Second, religious hypotheses may be strengthened by disproof. A puzzle which emerged from research on a religious movement led psychologist Leon Festinger to propose his theory of cognitive dissonance. (4) When a dissonant cognition is proved false by objective testing, the scientific solution would be obvious: Achieve consonance by discarding the unconfirmed hypothesis. But this is often precisely what individuals and groups do NOT do. The probability of rejection is not based on the disproof of the hypothesis but is inversely proportional to the individual's investment in it. In fact, in some of the most important issues humans face, failure may motivate an increase in the belief. A familiar model is provided by Christianity, which started as a movement to reform Judaism and probably would have remained a small and unsuccessful attempt. However, the "failure" of Christ's predicted return forced the early church to create new cognitions; eventually, the church emerged victorious, to become the state religion of the Roman empire and of Christendom, and ultimately one of the world's most widespread faiths. What could be the value of a tool for acquiring knowledge that is based on disproved hypotheses? It allows humans to survive the truth, if that truth would precipitate despair which could impair species survival.

c) And, religion provides a built-in, self-activating mechanism for responding to widespread societal stress. In encounters between different cultures, religion can infuse people with hope in objectively hopeless situations and provide a mechanism for adapting to stressful conditions or threats to survival by reformulating their way of life. Anthropologist Anthony Wallace has produced a general theory on the process of major cultural-system transformation, which he calls "revitalization": A deliberate, organized, conscious effort by members of a society to construct a more satisfying culture. (5) Religion, when faced with intolerable conditions, can supply something that science is unwilling to supply : The resources to endure by creating for its believers a more satisfying world -- a world, if necessary, beyond objective reality. And, another world to live in, says Santayana, is what we mean by having a religion. (6)

Human biological success has been secured by an arsenal of resources that deal with the full range of human experience. Natural selection will judge those adaptive mechanisms -- not by their ability to acquire accurate knowledge of the universe -- but by their ability to ensure the survival of the species. Space travel will offer new and unpredictable circumstances to humans isolated from the home planet that gave us our original set of adaptations. Cultural diversity, like biological diversity, is likely to be an evolutionary advantage, particularly as we embark upon journeys of offworld migration and settlement. I say: Keep all our tools; we just can't tell which ones might come in handy in the future.

TWO WORLDS AND THE DIFFICULT SCIENCES

It is of course a truism that human live simultaneously in two worlds: The objective physical world outside and the subjective virtual world inside. Close your eyes and your mind is still watching. In fact, I would suggest that most people spend most of their time inside, even when their eyes are open.

A culture's worldview is the group manifestation of this human subjective reality. One of the most powerful models I have found in anthropology is that people in different cultures (including our own) act as if they live in different realities. (I am struck by the independent but remarkably similar theory developed about the same time in quantum physics about multiple alternate universes, each with their own laws of physics.)

Since our sanities require that we believe in our own version of reality, we assume that other cultures (or even other individuals) that don't agree with us must have a distorted view of reality (ours being the standard) and need to be argued, cajoled, forced or educated into the "right" way. Difference equals wrong. A lot of human history can be explained using this simple model.

Human subjective reality is much less accessible than objective reality to the scientific method. If what determines science is the methodology, not the data to which it is applied, maybe what we're talking about is not soft science, but soft data. This "soft data" aspect of our intelligence is of profound importance to our evolution.

My friend, anthropologist Gregory Bateson, used to say: "There are the hard sciences and then there are the difficult sciences." Human problems -- unlike technological and physical ones -- commonly have no solutions, only resolutions, which are by their nature temporary, context-specific and variable; and levels of predictability will likely always be lower than in the hard sciences. While this may seem small help to the engineer and challenges the scientific credibility of the human factors researcher, it is the greatest advantage of our species and the primary reason for our biological success. (7) I'm suggesting that, among intelligences on this planet, the human variety is unique in a very peculiar way.

THE HUMANS MUST BE CRAZY (8)

If the selective value of intelligence is the ability to acquire information from the environment and then use such learned knowledge to manipulate that environment, then its selective value ought to be as a problem-solving tool, based on defining a causal chain and utilizing the logical paradigm of "if-then" -- "If me hit pig with stick, then me eat." And all intelligent behavior ought to be elaborations on this theme.

But, however useful, this is really pretty simple machinery, and, using this logic, even flatworms can learn to run a maze. And this does not explain what for me is the diagnostic feature of distinctively human intelligence. I don't think the data supports the notion that we are so successful simply because we are the smartest of the range of intelligent species on the planet. none of which come anywhere near us in success. On the contrary, what is responsible is not our intelligence, but the particular -- and peculiar -- way in which we have applied it.

We don't just use reality, we create it; and "let's pretend" requires more profound intellectual gymnastics than "if/then." Human world views do not seem to be based only on objectively-verifiable sensory data (or they'd be all the same), nor even on strictly objective projections from that data (or they'd all be logical or mechanical). Rather, world views are more or less arbitrary creations from an amalgam of data, experience and tradition. Language, symbols, metaphors, art, theoretical models in religion, philosophy, and science all depend not on facts but on consensus about intuitive relationships not necessarily supported by objective reality. The worlds that human beings live in -- their cultures -- are the original virtual realities.

Some friends of mine in anthropology have some interesting ideas on how this works. (9) The human brain has been built by evolution to (among other things) solve causal chains -- if-then problems. This was highly adaptive in any environment. It permitted us to look for the causes of the phenomena which were occurring around us and to attempt to control them. This has resulted, however, in a peculiarity: If the sensory data available for any particular unusual phenomenon are insufficient to explain the "cause" in the perceived causal chain, then the brain is "forced" by its own hard wiring to automatically grind one out -- i.e., to generate an explanatory model of reality deriving its elements -- not from the inadequate environmental data -- but from previously-learned material stored in the memory banks. This argument, in one fell swoop, can explain god and religion, art, poetry, philosophy, scientific theory-building -- in fact most of what we call significant human achievements.

The motley medley of the logical and illogical, rational and irrational, sane and insane that constitute human subjective reality makes us unique on this planet and has somehow gotten us to both God and space. To put it another way: The humans must be crazy. And being crazy has been very, very good to us.

Such an arbitrary creation of reality ought to be dysadaptive, because it is based on "false" information; and must surely be viewed -- by an objective, outside (i.e., nonhuman) observer -- as an aberration, a mental illness, a sort of species-specific schizophrenia which constructs another world to live in beyond the empirical one. Yet our evolutionary success is an undeniable testament to the fact that these created realities have been selected for rather than against. And the archeological record demonstrates

that it is this very elaboration of created realities in religion and art -- not bipedalism or tool use -- that accompanies the rapid increase in brain size. Our large brains (and presumably our peculiar intelligence) are not the driving force of human evolution but its result.

What could be the adaptive value of being crazy?

For one thing, it makes us unpredictable. To use the phraseology of Castaneda (which may be false to the data but true to human experience), it is unpredictability that separates the hunter from the hunted and distinguishes the man of power from the ordinary mortal. It may be this very arbitrariness of human-created worlds -- we don't follow the natural rules -- that turned our pint-sized, two-legged, scavenging ancestors into such formidable competitors. We became wild cards, loose cannons in evolution, reality-creating madmen who haven't yet been able to be driven into extinction by any forces of nature and whose madness (a wild concoction of if/then and let's pretend rationales) somehow eventually got us to heaven, hell and the moon. And natural selection has bought the package.

Our intelligence certainly can build a body of scientific knowledge that can allow us to analyze and control physical reality; but it can also, when necessary, provide a mental world for individuals and societies that has allowed survival, regardless of physical reality.

THE HUMAN/TECHONOLOGY PARTNERSHIP (10)

The primary jargon term in anthropology is "culture," which is much more encompassing than its common use among laymen. In fact, anthropologists themselves disagree about its definition.

By culture, I mean all human non-biological strategies for adaptation: All our learned, shared and patterned ways of thinking, feeling and acting -- plus their material manifestations in technology. Thus, I think of culture as "metabiology," in much the same manner as we use metaphysics: i.e., Everything we use to adapt to our surroundings that is not an original part of our bodies. Our brains are biology; our minds are culture. The brains of Plato, Dante and Einstein are dead; their minds are still with us.

This approach leads me to the idea that humans are not really just a species, but rather a partnership -- a partnership between our native biology and our acquired culture. We aren't BORN human, we BECOME human, as we incorporate our society's metabiology into our organic raw material; DNA is not enough to make a human being.

I am arguing that human beings became cyborgs -- organic/inorganic systems -- at the very moment one of our early hominid ancestors millions of years ago picked up that first rock and used it to modify its environment in a way that its body could not. Ever since, we and our technology have been inseparable partners. As this partnership between biology and culture succeeded over the millennia, the dividends increased as the cultural shareholder acquired a greater and greater percentage of the corporate stock.

All this suggests a possible evolutionary continuum -- no news to this crowd: From organic to inorganic, carbon to silicon, natural to artificial -- in my terms, biological to cultural. However, if the human species is considered as an organic/inorganic partnership, then our particular evolutionary path may demonstrate a unique and viable option -- unique on this planet, but therefore also possible elsewhere: Namely, that one of the many paths that could result from biological evolution is that a fully organic life form (e.g., the earliest hominid) begins to apply its natural equipment (e.g., intelligence, bipedalism) to increasingly incorporate the environment outside itself as part of its adaptive strategy (e.g., culture) until it ultimately "becomes" fully, 100% inorganic.

From this perspective, then, merging with our machines makes us MORE human -- not less human. Further, our present inorganic artificial intelligences become the primitive current representatives of the most advanced, ultimate extreme of this human continuum -- that is, machines, being created, are "pure culture." Our future starfaring robots, androids and probes -- their culturally-programmed minds secure inside inorganic bodies resistant to vacuum, temperature and radiation -- may legitimately BE the genuine, bonafide human beings of that far time. Whether this will enhance our evolutionary fitness in all contexts is by no means certain. Nonetheless, when people complain today about our becoming too technological, they are mourning, I think, not the loss of their humanity, but the loss of their biology.

Whether these far-future human stafarers are combined into a single organic/inorganic package or "jobbed out" among two or more separate kinds of individuals, it will probably remain true that we can do things machines can't do; machines can do things we can't do; together, we can do things nobody can do. Such an integrated, corporate species may advance beyond the limitations of either partner to a new level of understanding and interaction with whatever other beings with whom we may share this wide, wide, universe.

THE EXPLORATORY IMPERATIVE (11)

Migration is a natural process built into many living systems and eventually necessary for their ongoing biological success. I am thinking here not only of obvious situations like animal (including human) populations expanding into new regions which allow them to exploit an increased resource base, but also of diseases achieving advanced parasite status by becoming communicable; or of a biosphere reproducing -- whether by the natural and most likely means of having its bacteria blown into the cosmos or by evolving, against all odds, a species which develops an "artificial" means like space travel. In either case, a planet's biological success -- like any other parent's -- might be judged by whether or not it sends a genetic message to the stars before its primary goes nova.

Exploratory behavior in humans (as well as many other species) is commonly manifested as the initial phase of what I call the migration process, the final phase of which is colonization. Evidence from ethnography, history, archeology, primatology and

paleoanthropology all suggests that migration has always been a natural, consistent and adaptive practice of our evolving species, constituting the usual way of releasing recurrent pressures created by problems of politics, population or ecology.

Migration, then, probably serves many general adaptive functions, such as redistributing populations in accordance with environmental carrying capacity or reducing over-exploitation of available resources, increasing variability by enlarging the gene pool, expanding the range (and perhaps the biological success of the species), and redirecting "destructive" aggressive anti-social behavior outward into "constructive" new patterns. Since this behavior is seen in our fossil past, in our closest primate relatives and sister lineage, the chimpanzees, and in prehistoric and historic human populations, the migratory impulse can be presumed to have a biological basis -- that is, to be part of human nature.

The fossil and archeological record supports this position. Over the past 4 million years of human evolution, there have been several great migratory "breakouts," empowered primarily by cultural innovations, or "enabling technologies." Tools allowed us to expand throughout the tropics in a couple of million years, fire opened the whole world to our species about one million years ago, plant and animal domestication allowed us to fill it in a mere ten millennia, and the industrial revolution allowed us to master it in centuries. And history provides innumerable specific examples of human populations on the move.

Space travel is, I believe, just the next logical step in our continuous human expansion and ought to be seen, not as a difference in kind, but a difference only in degree and scale from our earlier adventures. By now, it's an old human story, our epic, in fact: Once again, we are migrating across unimaginable distances to unknown places through a medium deadly to land dwelling, oxygen breathers, enabled only by our cultural innovations, our metabiology. Like seacraft and aircraft but in a more total way than ever before, spacecraft must be mini-worlds, Earths in microcosm, techno-ecologies terraformed to contain as well as carry human life offworld.

And what drives us? Though it may have seemed to the politicians, historians, social philosophers and the general public that the space race was primarily an ideological battle in the cold war, waged with the weapons of economics and technology, to prove who was right. It was, much more fundamentally (however subliminally), the first phase of our migration to the stars.

So, this great endeavor that we are all involved in -- this space stuff -- is not about science, or technology, or economics, jobs, grants or politics; it is about the future of our species. Humans invented the space program. No rocks, rhododendrons, rabbits or even robots want to go to space! WE are the driving force. And unless we convince our leaders, our public and -- most of all -- our children that we are poised on the brink of humankind's greatest adventure, then the space program will be driven -- often stalled -- by the vagaries of everyday events, unimaginative bureaucrats and the overwhelming question: What can get funded? What we're doing is bigger that.

So I have a mission: To make sure that humans stay at the center of the our evolutionary future in space. I'd like it to be the mission for all of us involved in the space program, policy and performance. Otherwise, we risk failing the future generations of humans who might hold a broader vision about the destiny of our species and may find it hard to forgive us for our small-minded, short-sighted lack of faith in humanity's ultimate potential. We have the chance to help make those decisions now. For myself, I want those future generations to be able to look out at the stars from other stars, and think back with pride and wonderment on us at the beginning of the space age for having kept the faith.

NOTES

(1) See my "Societal Impact Of The Discovery Of Extraterrestrial Life: Religion And Science As Adaptive Mechanisms" presented at the Societal Implications of Astrobiology Workshop, NASA Ames, 17 Nov 99.

(2) I cannot vouch for the accuracy of this model, which was reported in TIME Magazine, 11/8/99. However, if it is even close, it makes the point.

(3) The ideas on religion in this paper are presented in full in my 1996 article in the proceedings of "When Cosmic Cultures Meet," published by the Human Potential Foundation, Washington, DC.

(4) The story of the cult is recounted in Festinger, L, Rieken, Henry W. & Schachter, S., 1956, When Prophecy Fails, University of Minnesota. The hypothesis is developed in Festinger, L, 1957, A Theory of Cognitive Dissonance, Stanford.

(5) The original article setting forth this hypothesis is Wallace, A.F.C., 1956, "Revitalization Movements," American Anthropologist, LVIII, 264-281. The ideas are summarized in Wallace, A.F.C., 1966, Religion: An Anthropological View, Random House.

(6) Santayana, G., 1906, Reason in Religion, New York: Collier.

(7) For a fuller discussion of this, see the conclusion section of my "Anthropologists as Culture Designers for Offworld Colonies." Case For Mars III: Strategies For Exploration. C. Stoker, ed., American Astronautical Society/Univelt, San Diego, 1989.

(8) I first presented the following discussion, "The Humans Must Be Crazy," in"Galactic Club or Local Pub: Is Intelligence Universal?" Ames Seminar, CONTACT, NASA/Ames & Santa Clara, CA, 3/4-7/99.

(9) To my knowledge, these concepts were first presented by Eugene G. d'Aquili in "Mythaking: A Biogenetic Structural Analysis," at the American Anthropological Association meetings in 1974. A more recent summary is: d'Aquili, E.G & A.B.

Newberg, 1999, The Mysical Mind: Probing the Biology of Religious Experince, Fortress Press, Minneapolis, MN.

(10) For a fuller discussion of this, see my "The Human Partnership: Machines R Us." Ames Seminar, CONTACT, NASA/Ames & Santa Clara, CA, 3/3-5/00.

(11) For the full discussion of this, see my "Biological And Cultural Drivers For Space Migration: The Dancer and The Dance". Ames Seminar, CONTACT, NASA/Ames & Santa Clara, CA, 3/2-4/2001.